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Scanning probe microscopy investigation of iron garnet films for magnetoplasmonics

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Synthesis and investigation of magnetoplasmonic (MP) nanostructures is relevant for construction of micro-dimensional optical isolators, modulators and switches, miniature integrated nanophotonic devices for fast multi-mode and multi-directional control, plasmonic circuit elements controlled by magnetic field [1]. For example, nanostructure "iron garnet (IG) – perforated Au film" experimentally demonstrated the effective modulation of transmission with contrast up to 98% using a weak external magnetic field [2]. Creation of metallic coating on IG films imposes specific surface requirements. Additionally, the films should have definite magnetic and magnetooptical properties [3]. In the work authors present the investigation of topography and domain structures of IG films proposed for magnetoplasmonic applications by scanning probe microscopy methods, including polarization near-field optical microscopy [4].

Films of bismuth-substituted IG with micro and nanoscale thicknesses were synthesized by liquid-phase epitaxy (LPE) and reactive ion beam sputtering (RIBS). Figure 1 (a) and (b) shows the typical surface of LPE film with root mean square surface roughness (rms) of 2.1 nm and its domain structure obtained by magnetic force microscopy with period of 16 μm, respectively. Measurements of various LPE films showed that rms could reach values less than 0.9 nm. Figure 1 (c) demonstrates the surface of deposited film with rms of 7.2 nm, which is determined by the size of polycrystals.

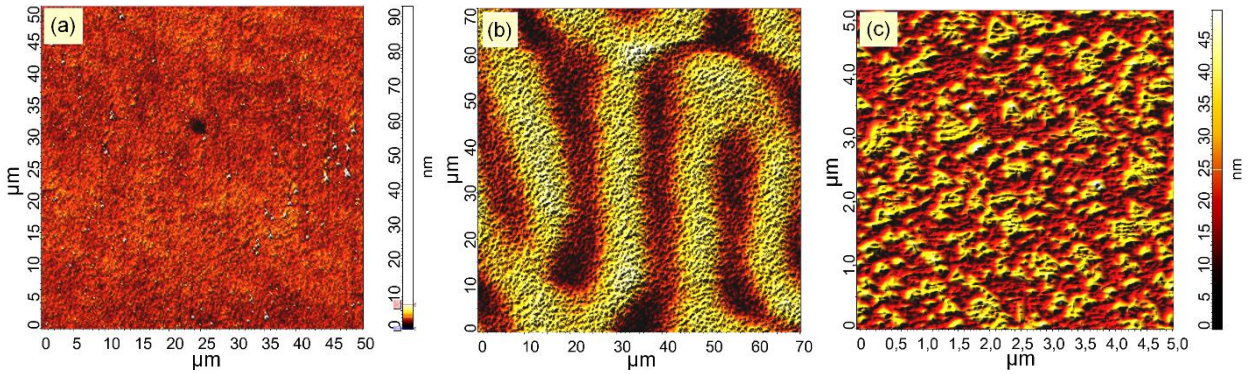

Figure 1. Typical (a) topography and (b) domain structure of LPE IG film and (c) topography of RIBS film.

Considerable attention was paid to minimizing the rms of samples in order to create on them plasmonic meta-surfaces perforated by nanoscale objects. Magnetic and magnetooptical properties of films were discussed also.

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